

Climate Change: How Much Time Do We Have?

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Univ of California at San Diego*

*UC-Mexico Working Group Meeting
Luncheon Speech, August 19, 2015*

UCSD, La Jolla, Ca





Greenhouse Effect Due to Chlorofluorocarbons: Climatic Implications

V. Ramanathan

SCIENCE
1975



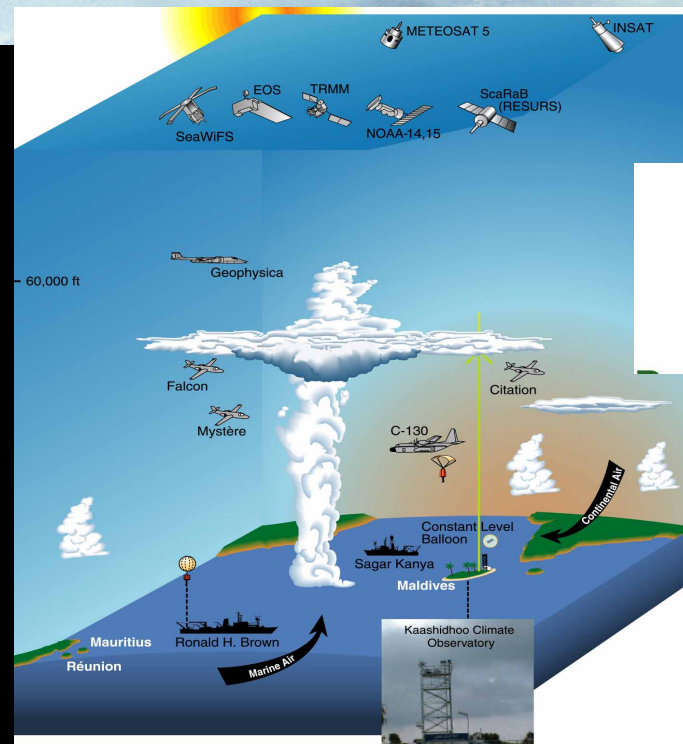
1975 discovery of halocarbon
greenhouse effect led to the short lived
climate pollutants mitigation in 2008



Ramanathan, Barkstrom and
Harrison, Physics Today, 1989

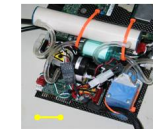
**CAUSES OF
CLIMATE
CHANGE
HAVE ALSO
BEEN DEDUCED
FROM
OBSERVATIONS**

Ramanathan et al,
Nature, 2007



Ramanathan , Crutzen ,
Et al, 1998

Miniaturized
Instruments for
UAV



Optical Particle Counter (500 g) →
 $N_{\text{aer}}; 0.3 < D_p < 3 \mu\text{m}$



Condensation Particle Counter (870
g) → $N_{\text{aer}}; D_p > 10 \text{ nm}$



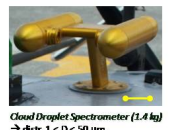
Aerosol inlet & splitter (150 g)
→ unheated aerosol sampling



Anethometer (100 g)
→ absorbing aerosol



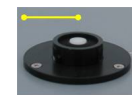
T/RH probe (50 g)
→ Temperature & RH



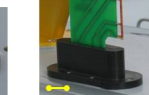
Cloud Droplet Spectrometer (1.4 kg)
→ $d_{\text{aer}}; 1 < D < 50 \mu\text{m}$



Pyranometer (190 g)
→ irradiance 0.3–2.8 μm



IR radiometer (45 g)
→ irradiance 400–700 nm



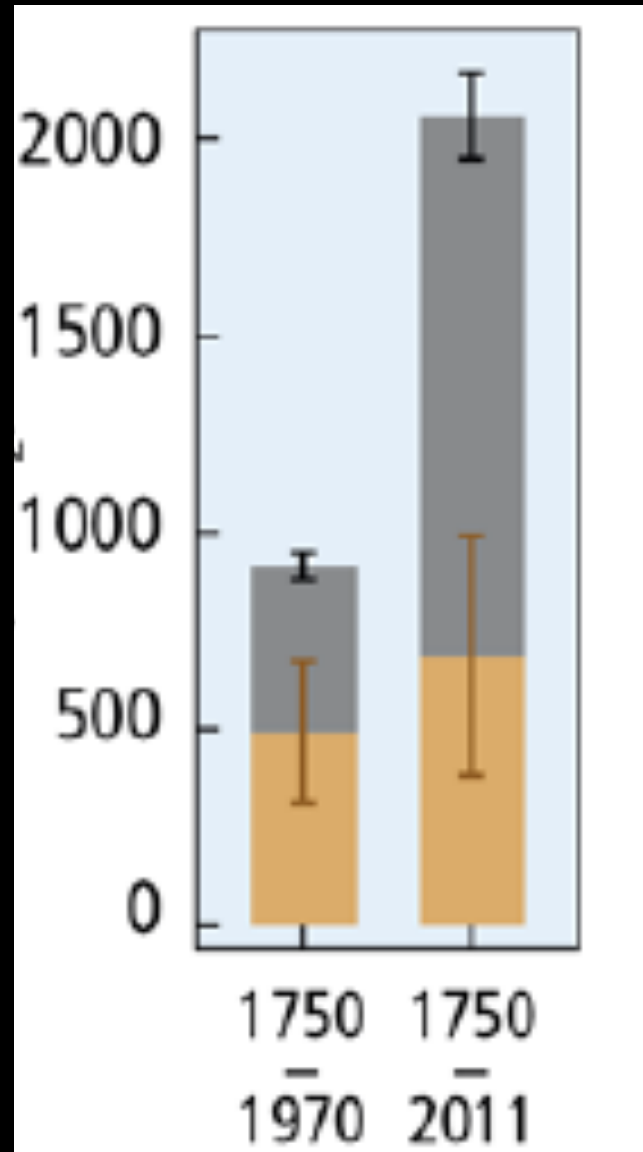
LWC probe (450 g)
→ Cloud water (g m^{-3})

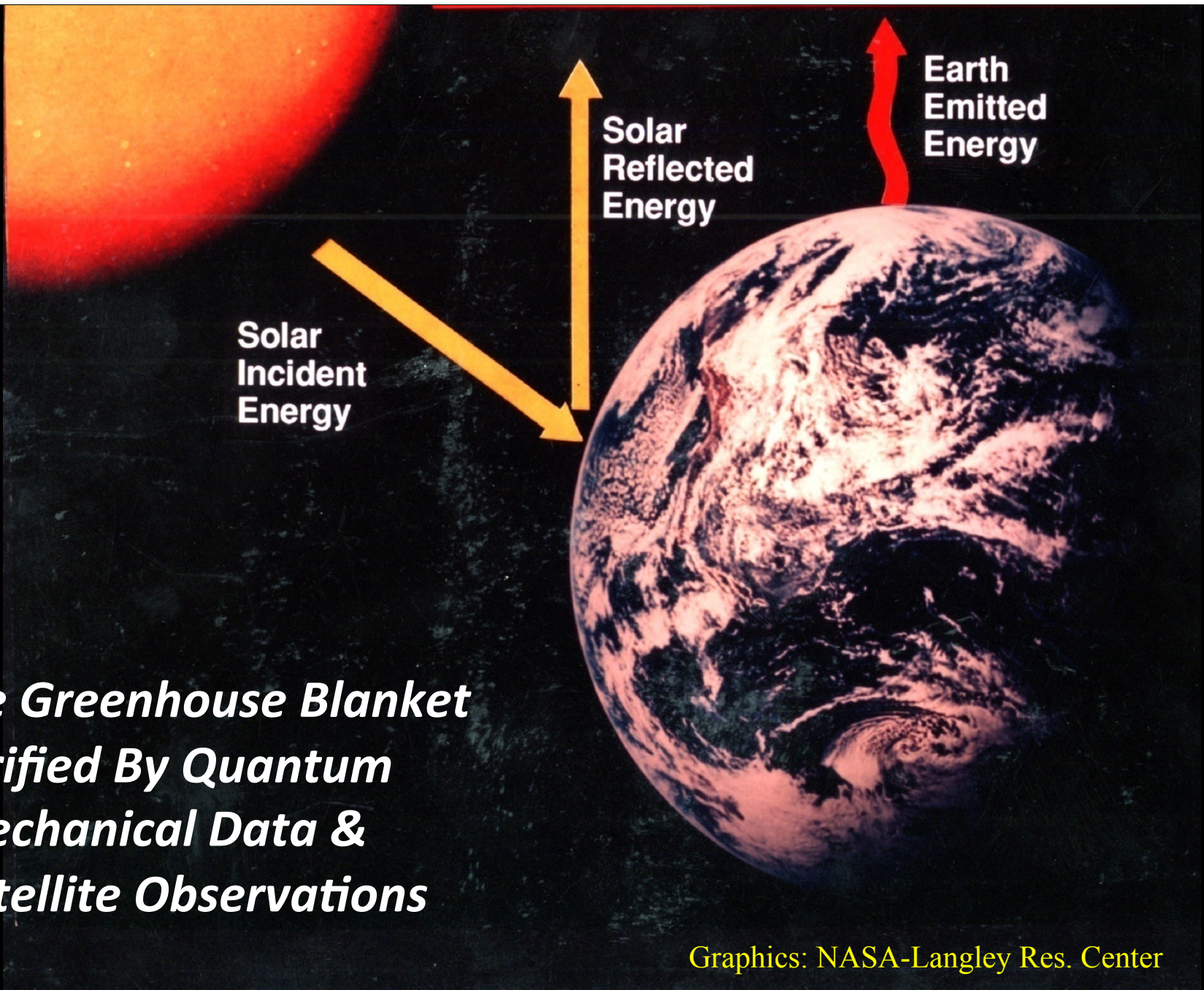


Video camera (280 g)
→ cloud targeting

Two Trillion Tonnes Of Carbon Dioxide Have Been Emitted So Far

CO₂ EMISSIONS, BILLION TONS





The diagram illustrates the greenhouse effect. A large, glowing orange and red sun is in the upper left corner. A yellow arrow labeled 'Solar Incident Energy' points from the sun towards the Earth. The Earth is shown as a blue and white sphere with clouds. A yellow arrow labeled 'Solar Reflected Energy' points away from the Earth's surface towards the top. A red wavy arrow labeled 'Earth Emitted Energy' points away from the Earth's surface towards the top right. The background is black space.

Solar
Incident
Energy

Solar
Reflected
Energy

Earth
Emitted
Energy

***The Greenhouse Blanket
Verified By Quantum
Mechanical Data &
Satellite Observations***

Graphics: NASA-Langley Res. Center

JUDGING A THEORY BY ITS PREDICTIONS

15 AUGUST 1980

SCIENCE

Detecting Climate Change due to Increasing Carbon Dioxide

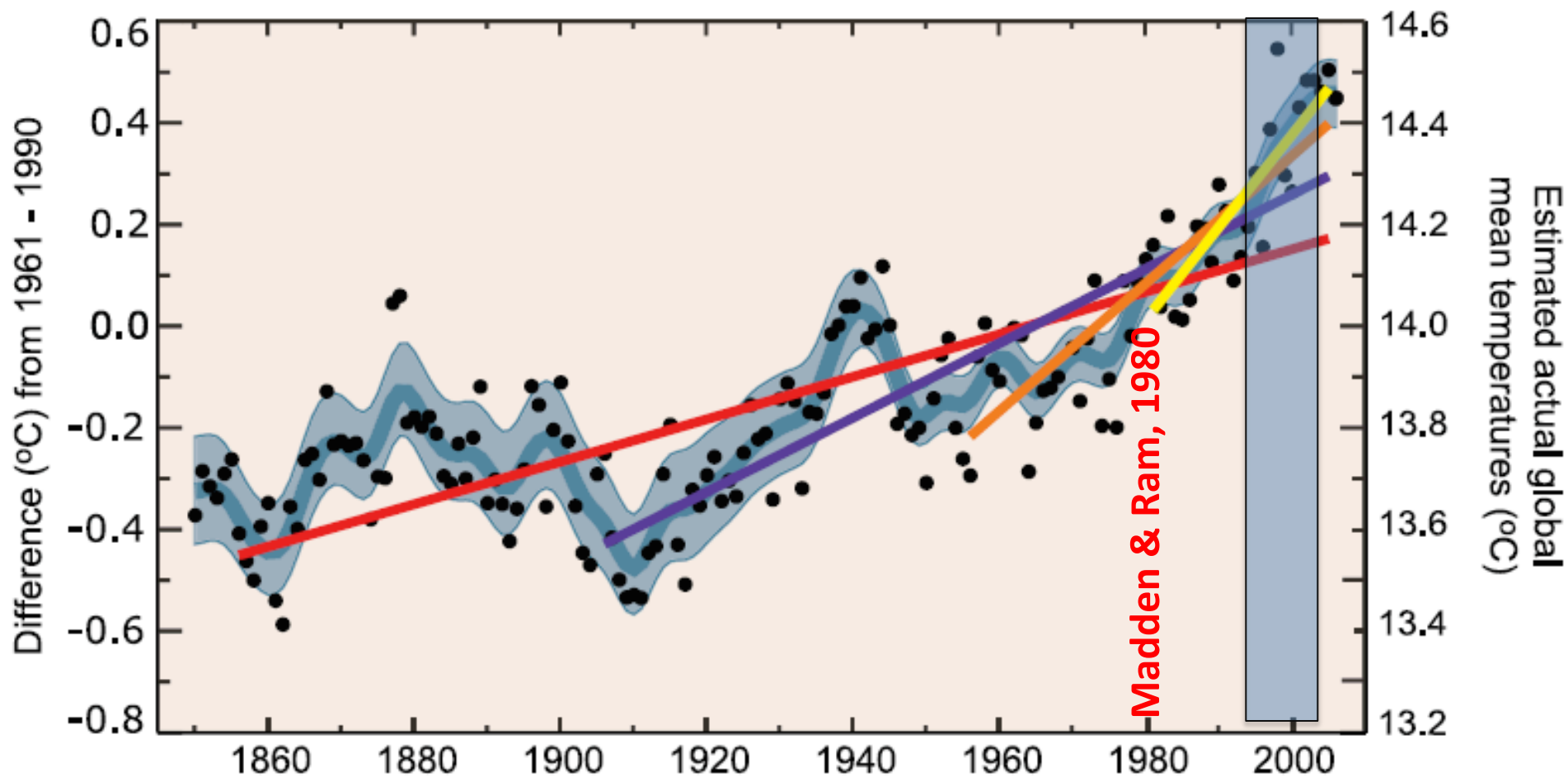
Roland A. Madden and V. Ramanathan

PREDICTION

***WARMING DUE TO CO₂ SHOULD BE
DETECTABLE BY YEAR 2000***

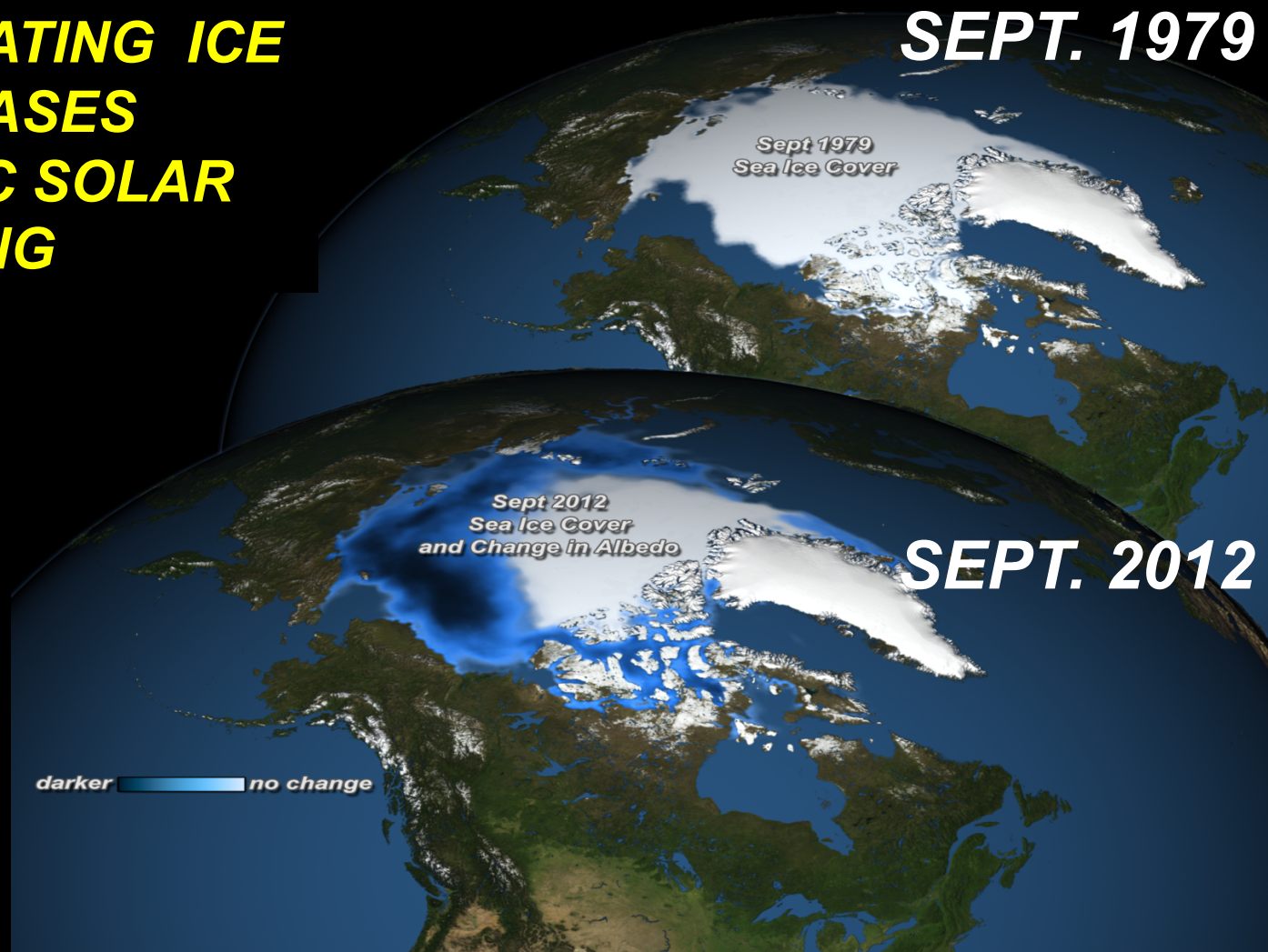
“Unequivocal” Warming of the Planet: IPCC, 2001 & 2007

Global Mean Temperature



NON-LINEAR FEEDBACKS KICKING IN

**RETREATING ICE
INCREASES
ARCTIC SOLAR
HEATING**



PISTONE, EISENMAN, RAMANATHAN, PNAS, 2014

POLEWARD SHIFT OF STORM TRACK CLOUDS

**Frida A-M. Bender • V. Ramanathan •
George Tselioudis**



CLIMATE DISRUPTION: WHAT IS IN STORE
Planet Has Already Warmed By 0.9 C [1.5 F]

NEXT THREE DECADES (2 C)

- ***DROUGHTS; HEAT WAVES; FOREST FIRES; INTENSE HURRICANES-TYPHOONS; MORE RAPID RETREAT OF GLACIERS AND SNOW PACKS***

BEYOND 2050 (4 C)

WARM-HUMID PLANET UNLIKE ANY THAT HAS BEEN EXPERIENCED IN THE LAST SEVERAL MILLION YEARS.

MOST WORRISOME IS THE FAT-TAIL

THE LANCET

THE LANCET COMMISSION ON HEALTH AND CLIMATE CHANGE [WATTS ET AL; JULY 2015]

- *Climate Change Greatest Threat To Global Health*
- *3 Billion Additional Annual Exposure Heat-wave Events For Elderly*
- *Women, Children And Poor Worst Affected*
- *Threaten To Undermine Last Half-century Of Development Gains*
- *Climate Change..... A Medical Emergency*

HOW DO WE BEND THE CARBON EMISSIONS CURVE

INTER-GENERATIONAL EQUITY

- *Reduce carbon emission by 80% by 2050 and to zero by 2080*

**CA AS BEACON FOR THE WORLD; UC DEMONSTRATING ART OF THE POSSIBLE
THROUGH THE CARBON NEUTRALITY INITIATIVE**

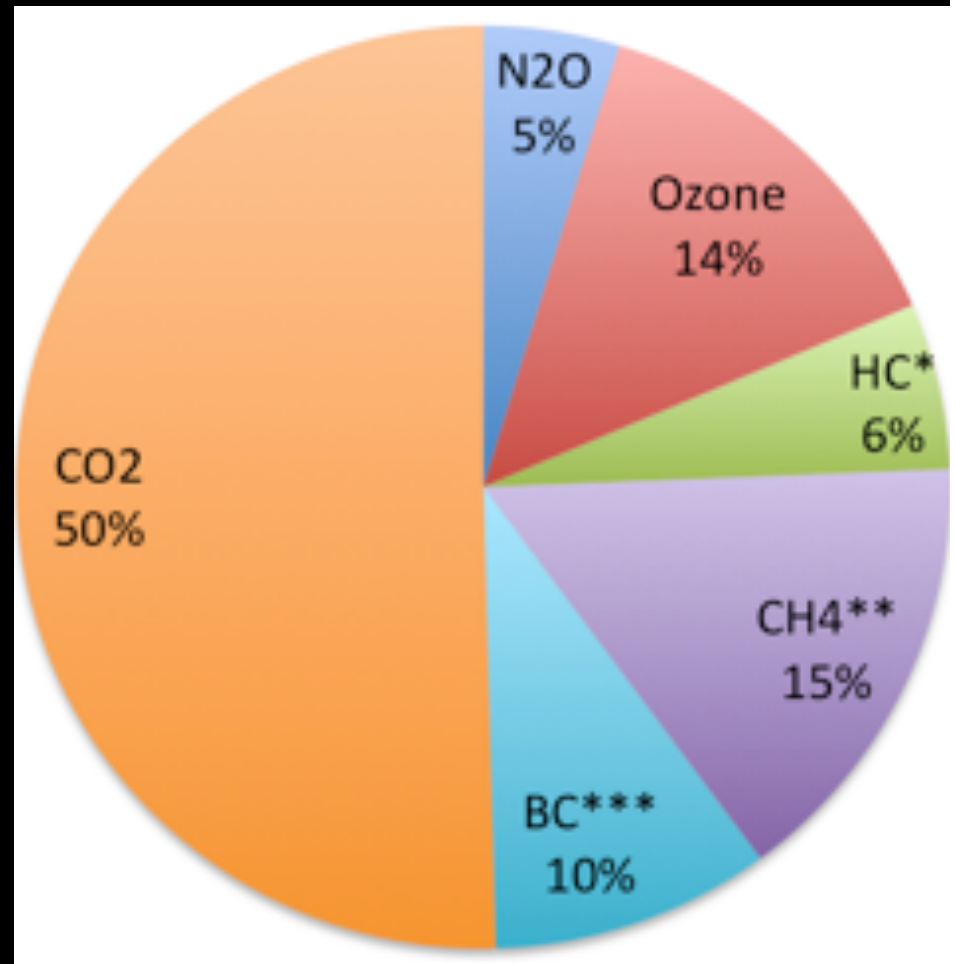
INTRA-GENERATIONAL EQUITY

- *Provide Clean Energy Access To The Bottom Three Billion*

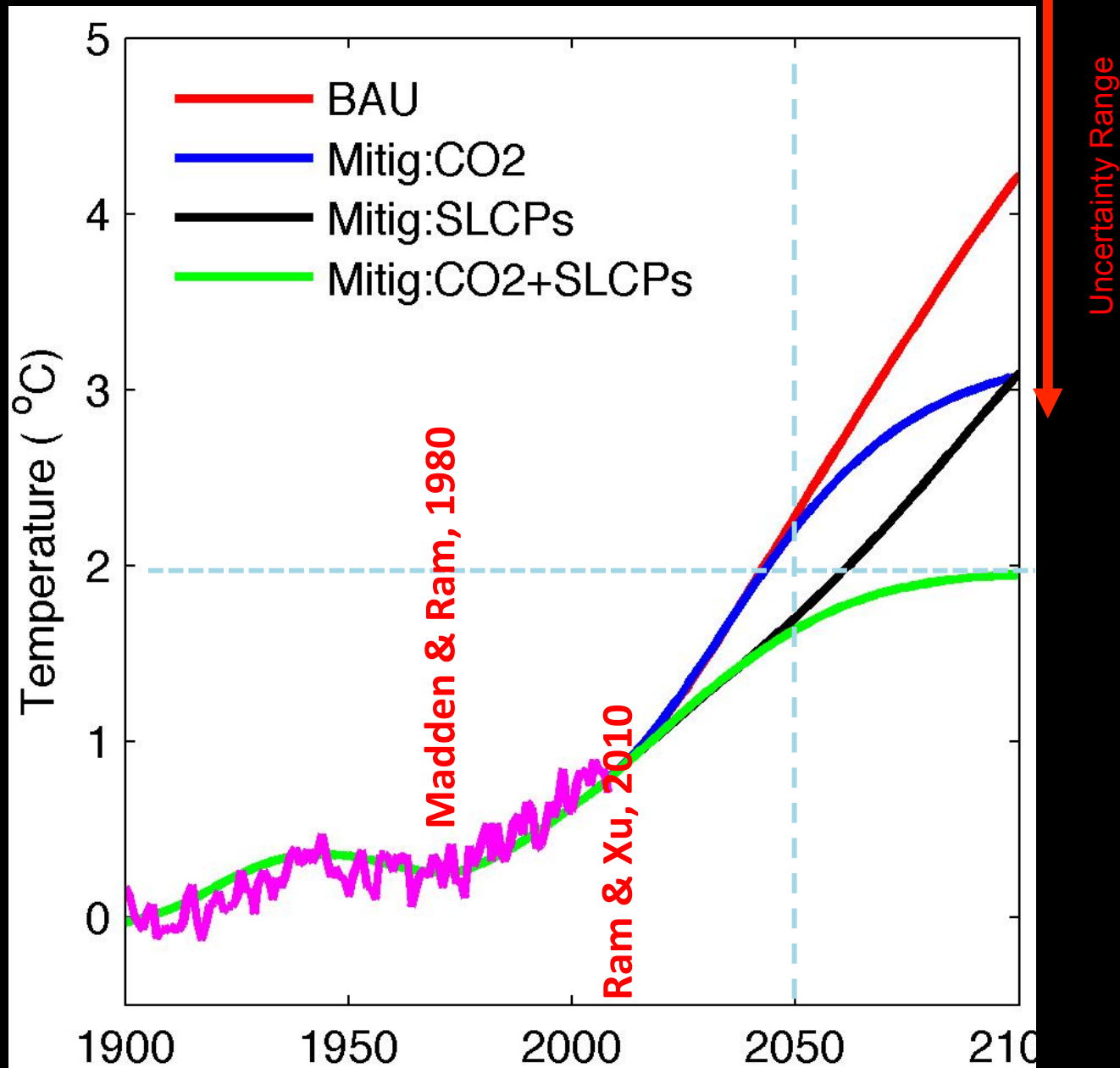
BENDING THE WARMING CURVE REQUIRES MITIGATION OF CO₂ & FOUR SHORT LIVED CLIMATE POLLUTANTS

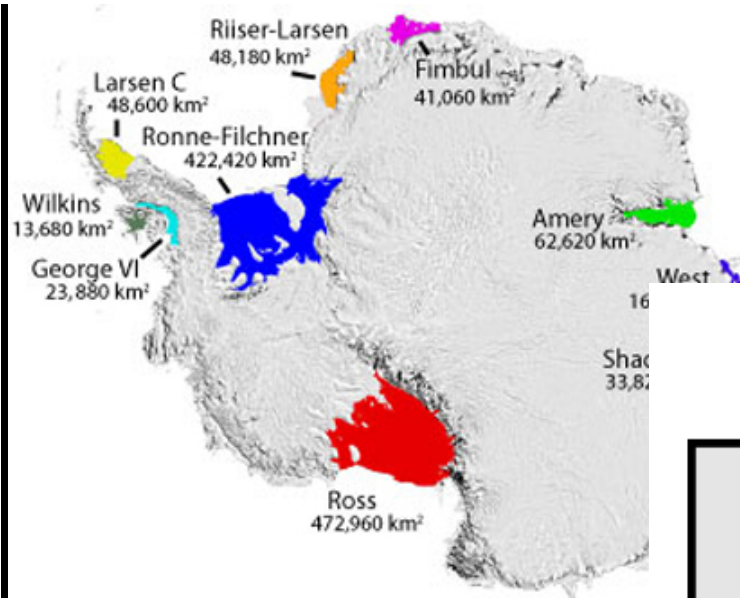
Ramanathan And Xu, 2010

***THE SHORT LIVED POLLUTANTS
CAN CUT NEAR TERM
WARMING TREND BY 50%***



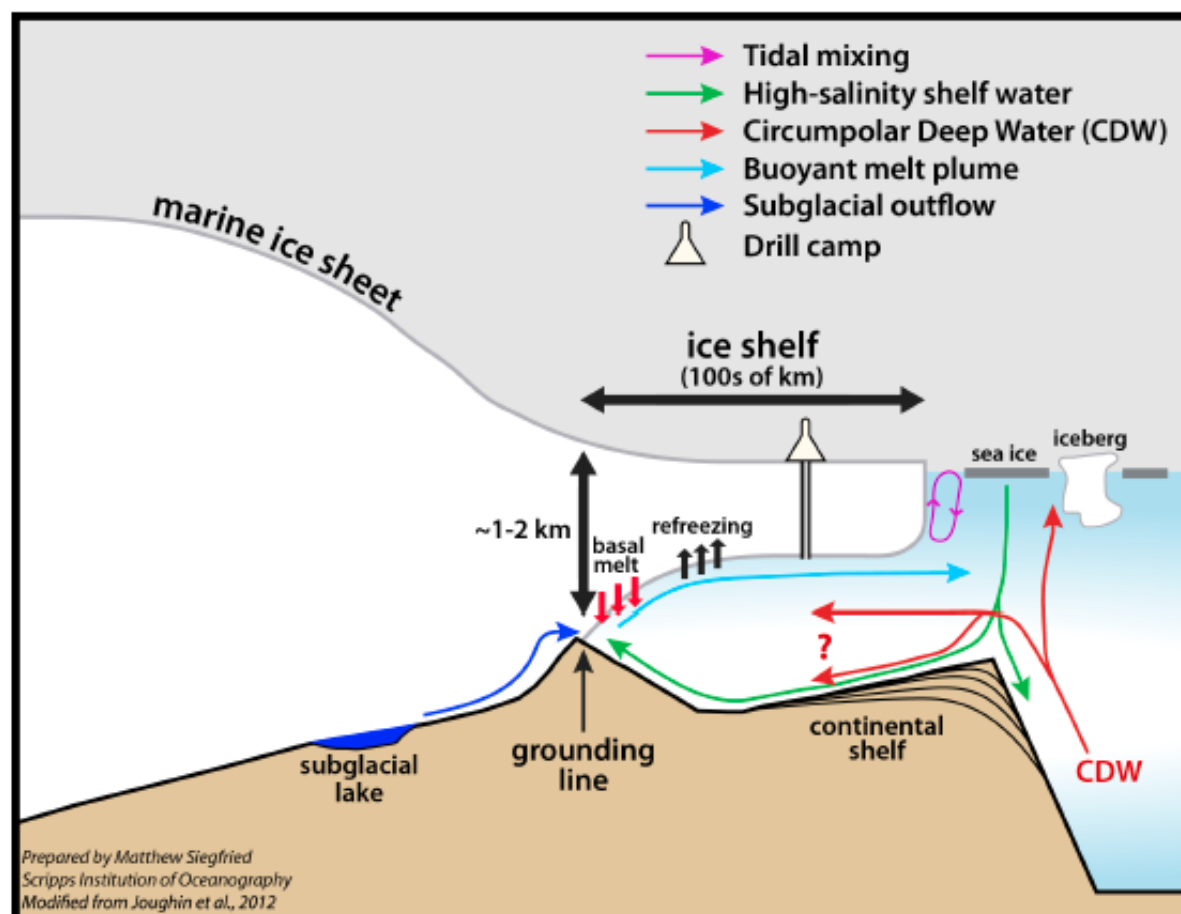
NEED TO MITIGATE BOTH CO₂ AND SLCPs





NON-LINEAR FEEDBACK UNDERWAY WEST ANTARCTIC ICE SHEET REF: H. FRICKER, SIO-UCSD

Marine ice sheet instability



Military Advisory Board

General Paul Kern, USA (Ret.)

Brigadier General Gerald E. Galloway Jr., USA (Ret.)

Vice Admiral Lee Gunn, USN (Ret.)

Admiral Frank "Skip" Bowman, USN (Ret.)

General James Conway, USMC (Ret.)

Lieutenant General Ken Eickmann, USAF (Ret.)

Lieutenant General Larry Farrell, USAF (Ret.)

General Don Hoffman, USAF (Ret.)

General Ron Keys, USAF (Ret.)

Rear Admiral Neil Morisetti, British Royal Navy (Ret.)

Vice Admiral Ann Rondeau, USN (Ret.)

Lieutenant General Keith Stalder, USMC (Ret.)

General Gordon Sullivan, USA (Ret.)

Rear Admiral David Tittle, USN (Ret.)

General Charles "Chuck" Wald, USAF (Ret.)

Lieutenant General Richard Zilmer, USMC (Ret.)



National Security
and the
Accelerating Risks
of Climate Change

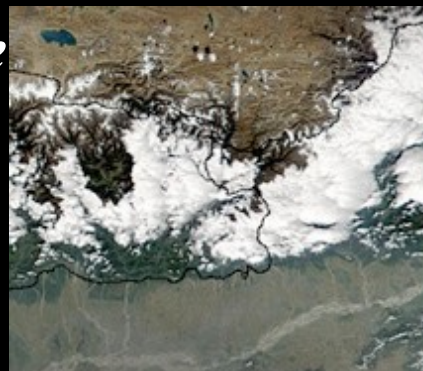
***SOME IN THE POLITICAL REALM
CONTINUE TO DEBATE THE CAUSE OF A
WARMING PLANET AND DEMAND
MORE DATA. YET MAB MEMBER
GENERAL GORDON SULLIVAN, UNITED
STATES ARMY, RETIRED, HAS NOTED:***

***"SPEAKING AS A SOLDIER, WE NEVER
HAVE 100 PERCENT CERTAINTY. IF YOU
WAIT UNTIL YOU HAVE 100 PERCENT
CERTAINTY, SOMETHING BAD IS GOING
TO HAPPEN ON THE BATTLEFIELD."***



the Pontifical Academy of Sciences

*Fate of Mountain Glaciers in the
Anthropocene. L. Bengtsson,
P J Crutzen & V. Ramanathan
2011*



*IF WE WANT JUSTICE AND PEACE, WE MUST PROTECT THE
HABITAT THAT SUSTAINS US*

Sustainable Humanity, Sustainable Nature, Our Responsibility .
Pontifical Academy of Sciences, May 2014

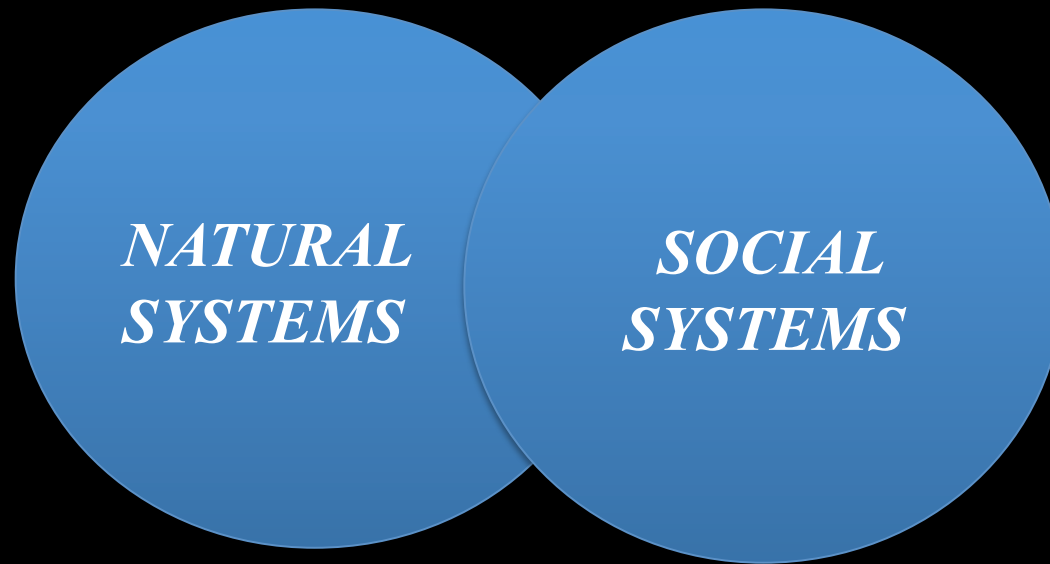


Sustainable relationship with nature requires change in attitude toward Nature and Towards each other and therefore requires moral leadership. Dasgupta and Ramanathan, Science, 2014





LAUDATO SI' USHERED IN THE AGE OF INTEGRAL ECOLOGY



- ***DEMAND AN INTEGRATED APPROACH TO COMBATING POVERTY, RESTORING DIGNITY TO THE EXCLUDED, AND PROTECTING NATURE..... LAUDATO SI'***